Concrete is considered as one of the most fundamental civil engineering building materials and has been under research for hundreds of years to determine its optimum applications. The addition of reinforcement materials such as fiber and bars have been determining factors when searching and testing for methods to improve the performance of concrete. Concrete without any reinforcement behaves strongly in compression, however, due to the tensile forces that it can experience due to orientations of loads and resistance to movements, it is expected to fail due to its deficiencies in elasticity and working stress. Thus, reinforcement is added to concrete to produce a near tensile strength level to that of its compressive strength. Throughout the years, steel has been the preferred choice of reinforcement for concrete due to its ability to increase the concrete’s overall capacity. However, the using of steel as reinforcement involves high costs and the possibility of corrosion which can negatively affect the durability of the concrete. Fiber reinforced concrete has become a popular choice amongst the civil engineering community due to the characteristics that can complement the structure of concrete. Using fiber as reinforcement has advantages like its high tensile to weight ratio, ability to be present uniformly throughout the concrete, and low maintenance cost. These properties make fiber reinforced concrete a suitable alternative to the typically used steel bar reinforced concrete. Research work has been carried out to determine if natural fibers are able to become a sustainable additive or replacement for steel reinforced concrete. Specifically, the coconut fiber, also known as coir, has been trending option for fiber reinforcement in the recent years for its low cost, abundance in third-world countries, and low impact to the environment.

**OBJECTIVES**

- To observe and evaluate the effects of coir fibers on the physical properties of general Portland Cement Concrete (PCC).
- To establish a standard method for batching Coir Fiber Reinforced Concrete (CFRC) while only utilizing the fundamental constituents of PCC.
- To observe the curing process of CFRC and subject concrete specimens to testing per American Society for Testing and Materials (ASTM) standards.
- To determine the advantages or disadvantages of using coir fibers as reinforcement for PCC.

**MATERIALS AND METHODS**

**Phase 1**
Gathering, testing, and prepping of materials and coir fiber rope for concrete mixing.

**Phase 2**
Batching of concrete mixture and molding into cylindrical and rectangular specimens for compressive and flexural tests.

**Phase 3**
Moisture controlled curing of specimens and testing for their respective strengths at 7 days and 28 days.

**Materials Used:**
- Sand
- Gravel (Max. Nominal Size ½”)
- Water
- Cement (Type V for High Sulfate Resistance)
- Coir Fiber (All-natural processed fiber rope)

**Tests Performed on Concrete Specimens:**
- Compressive Strength of Cylindrical Concrete Specimens (ASTM C39)
- Flexural Strength of Concrete Using Simple Beam with Third-Point Loading (ASTM C78)
- Moisture controlled curing of specimens and testing for their respective strengths at 7 days and 28 days.

The average compressive strengths of the 4”x8” cylindrical specimens are as follows, at 7 days of curing, for 0%, 2.5%, and 5% respectively: 2146.20, 1954.4, and 1703.0 pounds per square inch (psi); at 28 days, the average compressive strengths for 0%, 2.5%, and 0.5% respectively: 2731.3, 2230.3, and 1788.7 psi.

**RESULTS**

After subjecting the test specimens to their respective strength tests at 7 days (for compression only) and 28 days (both compression and flexure), it was determined that the addition of the natural coir fiber decreases the bonding cohesion of concrete when subjected purely in compression. However, when subjected to flexure (combination of tension and compression), concrete increased its resistance to failure when the coir content was at 0.25% of the specimen’s weight. Overall, the strengths of concrete decreased but its ability to avoid collapse was improved by the natural fiber reinforcement.

**CONCLUSIONS**

The results of this experiment showed that the compressive and the flexural strengths of general Portland Cement Concrete decrease at the addition of the natural coir fibers. Thus, the implementation of coir fibers in concrete adversely affects the strength property of the concrete. However, due to the coir fibers’ tensile strength, the fiber reinforcement was able to fulfill its purpose since, when the concrete reached failure, the specimen was held together in place and was prevented from collapsing. Reasoning why fibers tended to decrease the strength of concrete can be deduced from the retention of internal moisture by the natural fibers which hindered the concrete from properly curing. Concrete specimens were inspected after testing and it was observed that there was moisture in the interior of the specimens thus impeding the maturing of the concrete material. An additional observation was that when the content of coir fibers was increased beyond 0.5% of the total specimen weight, the fibers tended to lump together and flocculate, thereby, creating heavy concentrated masses of coir fibers which made the distribution of the coir reinforcement non-uniform throughout the specimen.

For future continuation of this project, testing of the concrete where the internal moisture has escaped the specimen by curing in the field would be an experiment objective to determine if the dissipation of internal moisture prior to testing will affect the strength of the concrete. Also, further research for this topic would relate to determining a method of preventing the fiber from absorbing a significant amount of water and analyzing if the reducing the size of the fibers when added to the concrete mixture, can promote uniformity across the testing specimens.

**References**

3. Majid Ali, Anthony Liu, Dr. Moses Karakouzian, Faculty Mentor, Civil and Environmental Engineering Institute. We would like to extend thanks to the staff of NOVA Geotechnical and Inspection Services for the mentoring and guidance of the Coir Fiber Reinforced Concrete production and testing processes.